

# Gender disparities in high-quality dermatology research over the past 15 years

Barak Zlakishvili, MD<sup>a</sup>, Amir Horev, MD<sup>b,c,\*</sup>

## ABSTRACT

**Background:** In the last 15 years, an increase in U.S. female dermatologists from 41 to 52.2% and a surge in female authorship (FAP) have been noted. Authorship is a pivotal objective measurement of academic productivity and, contribution as first or senior author, plays a major role in the promotion process of active physicians and faculty members.

**Objective:** To validate, analyze, and clarify trends in FAP in high-quality dermatology research in the last 15 years.

**Methods:** The Thomson Reuters Web of Science Journal Citation Reports 2021 was used to retrieve the 100 most-cited original articles from the top 5 dermatology journals (determined by 2021 impact factors) in 5 consecutive 3-year intervals between 2009 and 2023. Gender application programming interface, a gender algorithm, was used to identify FAP according to country of origin and first name. Monotonic trend test significance level was set at 5%.

**Results:** In total, 14,187 articles were retrieved and subdivided into the 100 most-cited in 3-year intervals. A total of 418 first and 447 senior authors' gender were identified. FAP was found in 43%, 31%, and 37% of the first, last, and total authors. Trend analysis revealed a decrease in the last 15 years ( $S = -4610$ ,  $P = .068$ ) in senior FAP. Similarly, the trend persists in the United States ( $S = -1606$ ,  $P = .052$ ).

**Limitations:** Due to the usage of a binary gender identification algorithm, Nonbinary gender could not be identified in this analysis.

**Conclusion:** The last 15 years show an inverse relationship, with an increase in female dermatologists and a decrease in senior FAP in high-quality journals in the general dermatology community.

**Keywords:** authorship, bibliometric analysis, dermatology, gender, research

## Introduction

In the last 15 years, a shift has occurred in the genders of active physicians in the field of dermatology. The percentage of female dermatologists in the United States has increased from 41 to 52.2%.<sup>1</sup> This trend was also present in the 3 decades prior to 2006, with a dramatic influx of female dermatologists into the field in the United States. Moreover, during those decades, a surge in female dermatologist authorship was noted in journals with high-impact factors (IFs) and high citation half-lives in the United States. For example, an observational study published in the *Journal of the American Academy of Dermatology*<sup>2</sup> showed a statistically significant increase during that period in U.S.-affiliated first authors (FAs) and senior authors (SAs), from 12 to 48% and 6.2 to 31%, respectively.

Academic authorship is a pivotal objective measurement of productiveness in academia and is often used when active physicians and faculty members are being considered for promotion.<sup>2,3</sup> In original articles, the FA is normally responsible for the execution and writing of the entire study, whereas the SA, due to status and contribution, makes the conduction of the paper possible but may not explicitly partake in major labor regarding the manuscript.<sup>4</sup> Senior researchers might prefer to be located last while young or less experienced researchers would normally be placed as FAs or coauthors, meaning that allocation as SA improves the standing and reputation of researchers more than FA or coauthor allocation.<sup>5,6</sup>

Several studies have been published on gender gaps in the field of dermatology. The study by Bendels et al.<sup>7</sup> indicated female FA and SA percentages of 50.2% and 33.1%, respectively. Two other studies focused on pediatric dermatology and contact

<sup>a</sup> Dermatology Department, Soroka University Medical Center, Be'er-Sheva, Israel

<sup>b</sup> Faculty of Health Sciences, Ben-Gurion University of the Negev, Be'er-Sheva, Israel

<sup>c</sup> Pediatric Dermatology Service, Soroka University Medical Center, Be'er-Sheva, Israel

\* Corresponding author.

E-mail address: amirhr@clalit.org.il (A. Horev).

Copyright © 2024 The Authors. Published by Wolters Kluwer Health, Inc. on behalf of Women's Dermatologic Society. This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

*International Journal of Women's Dermatology* (2024) 10:e160

Received: 15 October 2023; Accepted 14 May 2024

Published online 14 June 2024

DOI: 10.1097/JW9.000000000000160

## What is known about this subject in regard to women and their families?

- First and senior female authorship in high-quality research in the field of dermatology was growing between 2008 and 2017, alongside an increase of female dermatologists in the United States from 41 to 52.2%, between 2009 and 2023.

## What is new from this article as messages for women and their families?

- Analysis of publication trends in high-quality research in the field of dermatology between 2009 and 2023 revealed an increase in first female authorship and a decrease in senior female authorship.

dermatitis. The first found that female FAs and SAs comprised 71% and 65%, respectively.<sup>8</sup> The second study showed a significant increase in female authorship (FAP) between 1992 and 2019, from 37 to 66% for FAs and from 27 to 61% for SAs.<sup>9</sup> Thus, in the abovementioned analysis of the field of dermatology, the trends were less steep and showed a lower first and senior FAP than in subanalyses of subfields of dermatology, such as pediatrics or contact dermatitis.<sup>7-9</sup> Therefore, to further validate and report gender disparities in high-quality dermatology research, we focused our analysis on the 100 most-cited articles published in the top 5 Q1 dermatology journals in 3-year intervals between 2009 and 2023.

## Materials and methods

Bibliometric analysis is a method used to assess literature with metric tools, such as statistical analysis and refinement of extracted data regarding certain parameters, including citation rates, IFs, and country of origin. This analysis may help researchers reach conclusions regarding changes in research foci, topics, and study design over a period of time. For instance, analysis of the 100 most-cited articles in a certain period of time might reveal the changes, trends, and high-yield conclusions in a specific field and could identify gaps in knowledge and direct research needs.<sup>10,11</sup> For the current analysis, approval from an ethics committee was not required, given that no data collection or animal or human experimental interventions took place.

## Search strategy

Original articles published in the top 5 dermatology journals according to the Thomson Reuters Web of Science (WebOS) Journal Citation Reports 2021 were retrieved on May 11, 2023. Refinement and subdivision were conducted to include the 100 most-cited articles in each 3-year interval between 2009 and 2023. The 100 most-cited articles were refined as described previously by Mahamud and Mainwaring and by Bullock et al.<sup>12,13</sup> and the use of 3-year intervals was described by Baker et al.<sup>8</sup> To encompass the trends that have occurred over the years, we conducted the search using the following strategy: results were restricted to original articles in the WebOS category of dermatology between 2009 and 2023. Raw data and graphs were analyzed using Microsoft Excel software.

## Data extraction and bibliometric parameters

The original articles were extracted to Microsoft Excel 2019. The search results directly facilitated the retrieval of the title, total citations by the WebOS database, journal, year of publication, FA, and SA. The annual citation (AC) metric, which is total citations divided by the age in years of the publication, is a tool designed to counter the bias arising from older publications having more prominent citations over time.<sup>14-16</sup> The research focus was determined by screening the abstract, available full text, and keywords of the articles. Country of origin was recorded according to the FA's and SA's information for each article. Journal IFs were acquired from the 2021 WebOS database.

## Determination of gender

Gender application programming interface (GAPI) (<http://www.gender-api.com>) is a validated algorithm,<sup>17</sup> applied in previous work,<sup>8</sup> which uses social media and publicly available government databases to differentiate gender based on first name. GAPI was used to encode the gender of authors as either male or female. GAPI contains approximately 1,850,000 unique first names across 177 countries and

assigns relative gender probabilities of 0 to 100 for each name accordingly. Gender was coded M for male and F for female if the probability was 95% or higher that the name would match a specific gender. Unassigned gender was coded as N for "nonassigned."

## Statistical analysis

Statistical analysis was performed in JASP<sup>18</sup> and Microsoft Excel using XLSTAT. Data normality was assessed using the Shapiro-Wilk test and heterogeneity was assessed using Levine test. The categorical variable of gender was evaluated by assigning the value of 1 for females and 0 for males. Due to the lack of normal data distribution, statistical differences were evaluated for nonparametric data using the Kruskal-Wallis test with a Dunn post hoc test to compare groups on a dependent variable and using a Kendall tau-b correlation test with a significance level of 5% ( $P < .05$ ). A Mann-Kendall monotonic trend test was used for dependent variables in a time series with a trend significance level of 10% ( $P < .1$ ). The value of "S" in the Mann-Kendall test was calculated by comparing the values of subsequent gender values in the time series. For each comparison pair, the score was +1 if the latter value was greater than the former and -1 if it was smaller and all scores were then summed to calculate the test statistic "S." Thus, a positive "S" means that the trend for FAP is increasing while a negative "S" means that the trend for FAP is decreasing. The "Z" statistic of the Kruskal-Wallis test indicates how the average rank for a certain group, as calculated by FAP, compares to the average rank of all observations.

## Results

In total, 14,187 original articles in the field of dermatology were published between 2009 and 2023 in the top 5 dermatology journals and the 100 most-cited articles in each 3-year interval were retrieved (Fig. 1). The refined sample was ranked according to ACs and is shown in Supplementary Table 1, <http://links.lww.com/IJWD/A47>. Out of 500 original articles, 418 FAs and 447 SAs were identified by gender. FAP percentages comprised 43% for FAs, 31% for SAs, and 37% of the entire identified FAs and SAs ( $n = 865$ ). Mann-Kendall monotonic trend analysis conducted for FAP revealed a decrease in female SAs ( $S = -4610$ ,  $P = .068$ ). In order to examine clusters of countries from the United States and Europe, a Mann-Kendall test was conducted and showed a decrease in female SAs of American origin ( $S = -1606$ ,  $P = .052$ ). Furthermore, trends in FAP from European countries revealed a decrease in SAs. FAP, with regards to the cluster of European countries and United States together, showed an increasing trend in FAs over the study period. The trends of FA and SA FAP and the SA FAP of United States and European countries are shown alongside the rise in active female dermatologists in the United States in Figure 2. Kendall's tau-b correlation test conducted between FAP and ACs revealed a weak nonsignificant correlation for FAs and SAs. The Kruskal-Wallis test was conducted to examine the effect of different journals and research foci on FAP. While journals did not significantly affect FAP, a diagnostic focus had a significantly higher FA FAP than a focus on pathogenesis or treatment ( $z = 2.3$  and  $2.05$ , respectively;  $P < .05$ ). Furthermore, a medical education focus had a significantly higher FA FAP than a focus on pathogenesis or treatment ( $z = 2.42$  and  $2.12$ , respectively;  $P < .05$ ). Moreover, epidemiological studies had a significantly higher probability of FA FAP compared with pathogenesis-focused studies ( $z = 2.03$ ,  $P < .05$ ). Different research foci did not appear to significantly affect SA FAP. The trends FAP between 2009 and 2023 by research focus are presented for FA and SA in Figures 3 and 4, respectively.

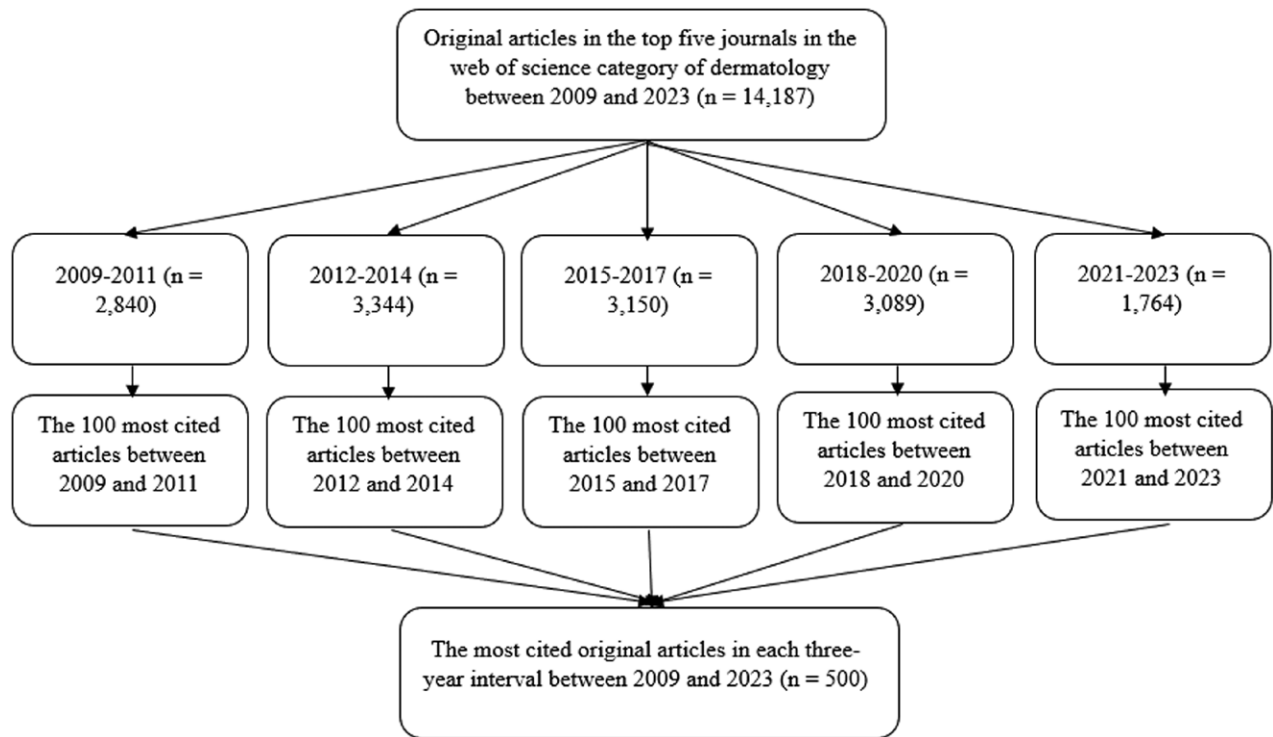


Fig. 1. The most-cited articles in the category of dermatology between 2009 and 2023, data extraction.

**Discussion**

Between 2010 and 2021, the percentage of female dermatologists in the United States steadily increased from 41 to 52.2%.<sup>1</sup> In our analysis, FA and SA FAP showed an increase and decrease, respectively. Furthermore, while the total FAP in our study (37%) was higher than in previous studies that analyzed the whole area of science (30%)<sup>19</sup> or focused on 6 high-impact medical journals (34%),<sup>20</sup> it was lower than the total FAP of 43% reported by Bendels et al.,<sup>7</sup> who analyzed high-quality dermatology research. This decline is an inverse trend from that of the other dermatology-related publications mentioned

earlier, which did not refine their data and included a large number of Q1 dermatology publications.<sup>2,7</sup> A plausible explanation for this difference might be the refinement methodology of our analysis, to include only the 100 most-cited original articles in the field of dermatology for each 3-year interval. This difference emphasizes that refining publications to include the 100 most-cited articles in each journal for each 3-year interval might reveal a different trend than a macro analysis of publications. This difference might be further supported by the fact that a focus on subfields in dermatology can shift the trends and present a different picture. When the studies by Feramisco

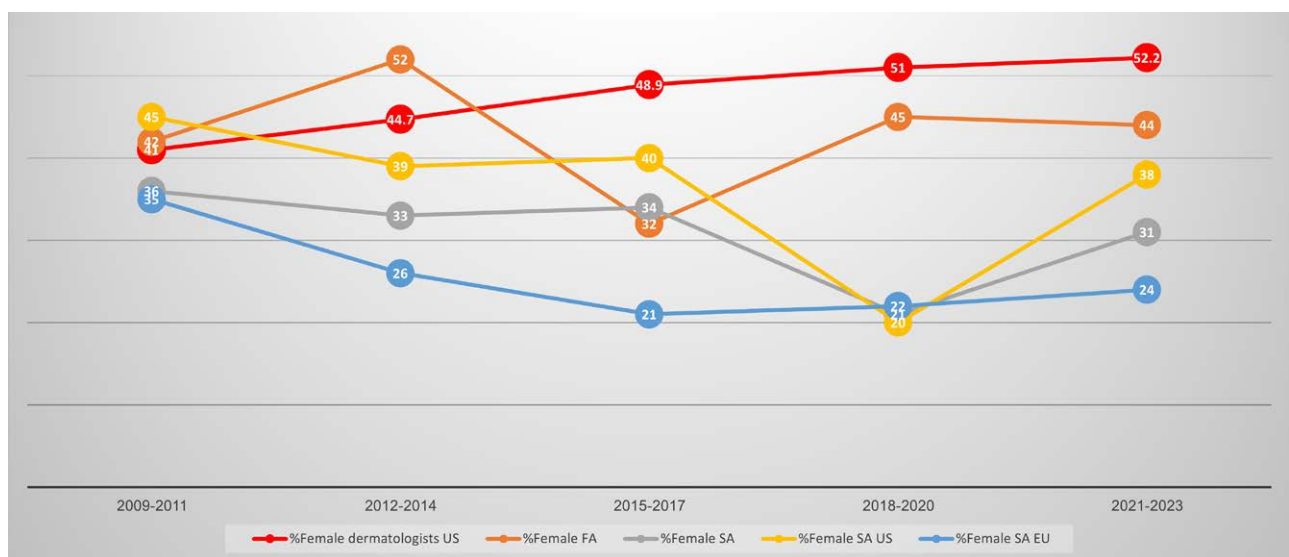


Fig. 2. Trends in first and senior female authorship and senior female authorship in the United States and European Union (EU), alongside the rise in U.S. female dermatologists.

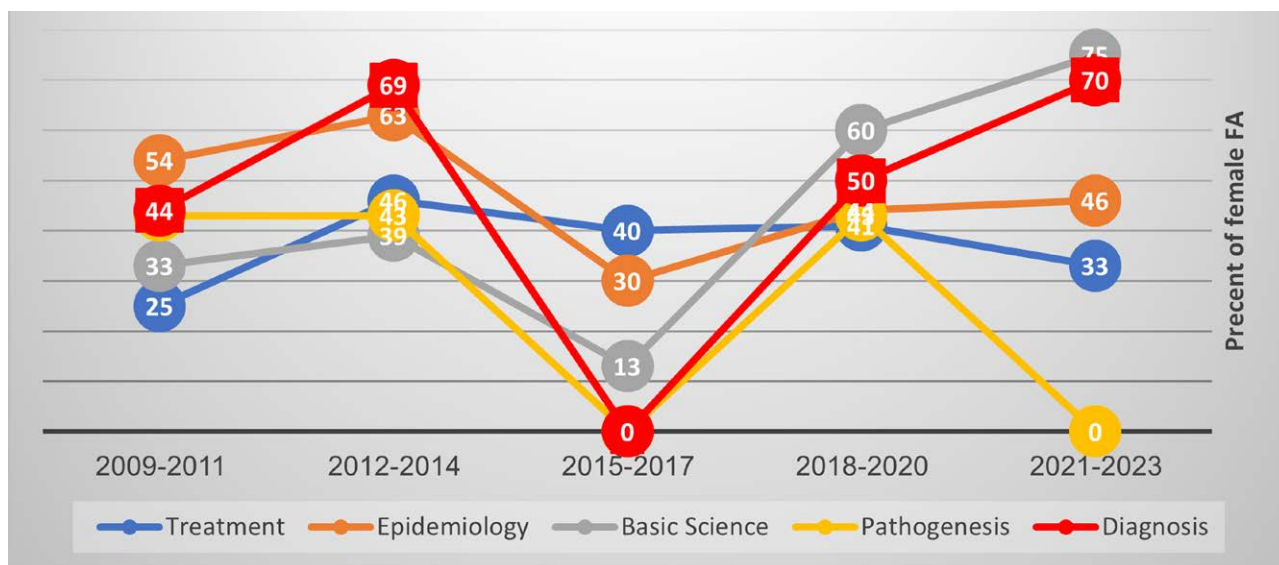


Fig. 3. Trends in female first authorship by research focus.

et al. and Bendels et al. are compared to other dermatological gender studies, several of the analyses showed higher percentages of FAP in recent years.<sup>2,7-9</sup> Nevertheless, our refined analysis revealed lower percentages of FAP and different trends in FAP. Our study shows a specific refined picture of FAP with an emphasis on the most-cited research in the top 5 dermatology journals, rather than a larger sample of publications that might introduce other trends. In a subanalysis of the separate effect of each journal on FAP, no effect was found for FAs and SAs, meaning that there was no significant disparity in the authorship of specific journals among those reviewed in our analysis. The same pattern was seen for the different effects of research foci on SA gender. Our examination of the effect of research foci on female FA revealed significantly higher FAP in a comparison of researchers who focused on diagnosis rather than on treatment or pathogenesis. The same pattern was found when the FA FAP of medical education was compared to that of treatment or pathogenesis and when epidemiological research was compared to pathogenesis research. This finding might illustrate that females who perform high-quality dermatologic

academic studies have taken prominent roles in these studies as FAs more in the foci mentioned above than in the above-stated areas of research in the past 15 years. The strength of our analysis is mainly derived from our refinement methodology that focused on the most-cited original articles in each 3-year interval from 2009. This method was conducted regarding the highest citations and IF in dermatology journals to capture bibliometric data of the highest-quality research in dermatology. Another strength of our study is the use of the GAPI algorithm to predict gender with at least a 95% probability to obtain an accurate picture regarding assigned at-birth binary gender trends and to allow the gender identification of authors by their country of origin and name. Nevertheless, there are several limitations to our study. First, our small sample of articles, which, on the one hand, serves as a focused picture of high-quality dermatology research and, on the other hand, might lead to deviations from the data presented by prior studies. Second, the authors' gender and profession might be misidentified. Nonbinary gender identities could not be included in this analysis due to the inability of the current algorithms

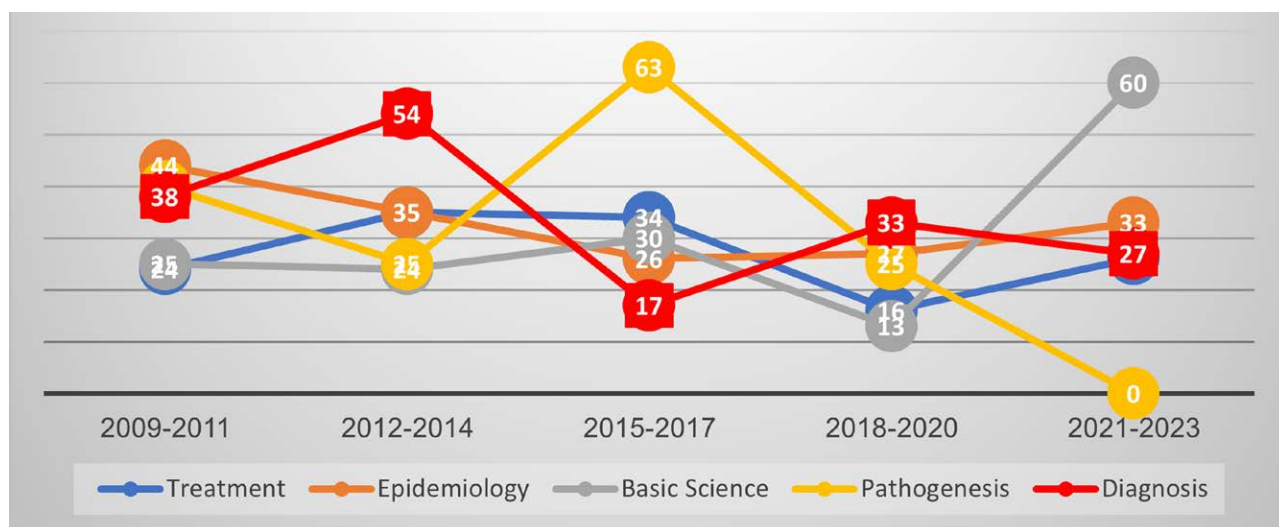


Fig. 4. Trends in female senior authorship by research focus.



and resources to designate genders assigned at birth other than binary male or female. This is countered by the level of probability of 95% used in the GAPI algorithm. Third, when extracting the data from WebOS, we could not analyze the position and profession of each author due to a lack of data. This could lead to the extraction of data in which some authors were from a discipline other than dermatology. To counter this limitation, we focused on the highest-quality dermatology research and further refined the results to include only those results that were published in the dermatology category in the WebOS database. Fourth, was our inability to locate a valid database that describes the rise in female dermatologists in the European Union in each 3-year interval between 2009 and 2023, as was found from the Association of American Medical Colleges. Thus, leaving us with the American data of active physicians by sex and specialty, without comparison to their European counterpart. Lastly, when considering the above presented rise in U.S. female dermatologists versus the decline in senior female authorship, we could not exclude a possible female preference for nonacademic private practice instead of academic research positions. This notion could serve as a possible explanation for our results and was not addressed in our study due to the lack of periodical data regarding private and academic dermatologic positions by gender. In our opinion, future research in gender discrepancies is of high importance and should further explore data regarding possible explanations for FAP trends, valid global demographic data, and private and academic dermatologic positions by gender.

In conclusion, we present a snapshot of FAP for the highest-quality research in the field of dermatology over the past 15 years. Our analysis of the literature has elucidated the dichotomy created between female FAs and SAs over the study period in the most-cited original articles in the global dermatology community and particularly in the United States. Further tracking and research of trends of FAP over the years is warranted for the further validation of FAP patterns. Accordingly, we hope that our article might open the way to additional research methodologies considering the effect of the choice of sample and subfield analysis on shifting a trend toward any increases and decreases identified.

### Conflicts of interest

None.

### Funding

None.

### Study approval

N/A

### Author contributions

BZ and AH developed the study, methodology, and design. BZ provided statistical analysis and wrote the first draft of the manuscript. AH supervised and reviewed the final version of the manuscript.

### Supplementary data

Supplementary material associated with this article can be found at <http://links.lww.com/IJWD/A47>.

### References

- Center for Workforce Studies at the Association of American Medical Colleges, (AAMC). AMA Physician Masterfile - Number of Active Physicians by Sex and Specialty. 2021. Available from: <https://www.aamc.org/data-reports/workforce/data/active-physicians-sex-specialty-2021>
- Feramisco JD, Leitenberger JJ, Redfern SI, Bian A, Xie X-J, Resneck JSJ. A gender gap in the dermatology literature? Cross-sectional analysis of manuscript authorship trends in dermatology journals during 3 decades. *J Am Acad Dermatol* 2009;60:63–9.
- Marušić A, Bošnjak L, Jerončić A. A systematic review of research on the meaning, ethics and practices of authorship across scholarly disciplines. *PLoS One* 2011;6:e23477.
- Murphy TF. In: McGee G, editor. Case. Cambridge, MA, 02142, USA: . The MIT Press, studies in biomedical research ethics. 1st ed. Cambridge, MA, USA: The MIT Press; 2004.
- Tscharntke T, Hochberg ME, Rand TA, Resh VH, Krauss J. Author sequence and credit for contributions in multiauthored publications. *PLoS Biol* 2007;5:e18.
- Fadeel B, Falagas ME. “But many that are first shall be last; and the last shall be first.” *FASEB J* 2009;23:1283–4.
- Bendels MHK, Dietz MC, Brüggmann D, Oremek GM, Schöffel N, Gronenberg DA. Gender disparities in high-quality dermatology research: a descriptive bibliometric study on scientific authorships. *BMJ Open* 2018;8:e020089.
- Baker C, Dwan D, Fields A, Mann JA, Pace NC, Hamann CR. Representation of women in pediatric dermatology leadership and research: trends over the past 45 years. *Pediatr Dermatol* 2020;37:844–8.
- Ziarati P, Baker C, Dwan D, Zug KA, Hamann CR. Representation of women among authors and presenters in contact dermatitis and at the European Society of Contact Dermatitis congresses: a look over 28 years. *Contact Dermatitis* 2020;83:537–8.
- Peles G, Horev A. A bibliometric analysis of hidradenitis suppurativa literature over the past 50 years. *Int J Dermatol* 2023;62:534–46.
- Carroll J, Alavi K. Pathogenesis and management of postoperative ileus. *Clin Colon Rectal Surg* 2009;22:47–50.
- Mahamud I, Mainwaring A. 50 years in urinary incontinence: a bibliometric analysis of the top 100 cited articles of the last 50 years. *Int Urogynecol J* 2022;33:919–30.
- Bullock N, Ellul T, Bennett A, Steggall M, Brown G. The 100 most influential manuscripts in andrology: a bibliometric analysis. *Basic Clin Androl* 2018;28:15.
- Antoniou SA, Lasithiotakis K, Koch OO, Antoniou GA, Pointner R, Granderath FA. Bibliometric analysis of scientific contributions in minimally invasive general surgery. *Surg Laparosc Endosc Percutaneous Tech* 2014;24:26–30.
- Mainwaring A, Bullock N, Ellul T, Hughes O, Featherstone J. The top 100 most cited manuscripts in bladder cancer: a bibliometric analysis (review article). *Int J Surg* 2020;75:130–8.
- Ellul T, Bullock N, Abdelrahman T, Powell AGMT, Witherspoon J, Lewis WG. The 100 most cited manuscripts in emergency abdominal surgery: a bibliometric analysis. *Int J Surg* 2017;37:29–35.
- Nielsen MW, Andersen JP, Schiebinger L, Schneider JW. One and a half million medical papers reveal a link between author gender and attention to gender and sex analysis. *Nat Hum Behav* 2017;1:791–6.
- JASP. JASP (Version 0.17.2)[Computer software]. 2023. Available from: <https://jasp-stats.org/>
- Larivière V, Ni C, Gingras Y, Cronin B, Sugimoto CR. Bibliometrics: global gender disparities in science. *Nature* 2013;504:211–3.
- Filardo G, da Graca B, Sass DM, Pollock BD, Smith EB, Martinez MA-M. Trends and comparison of female first authorship in high impact medical journals: observational study (1994-2014). *BMJ* 2016;352:i847.